LIGHTING DATA

EDISON LAMP WORKS
OF GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE HARRISON, N. J.

Lighting Legislation

Information Compiled by

G. H. STICKNEY

Lighting Service Department

PAGE

SYNOPSIS:

For information regarding MAZDA lamps and lighting questions, refer to the nearest sales office as listed on the last page of this bulletin.

To insure receipt of bulletins, notify the Department of Publicity, Edison Lamp Works of General Electric Company, Harrison, N. J., of any change of address.

LIGHTING LEGISLATION

Information Compiled by G. H. Stickney
Lighting Service Department

Introduction

During the last decade lighting codes, having as their object the promotion of safety and protection of the public, have been adopted in the various states of the Union. Previous to 1913, some legislation had been undertaken, but was apparently proving ineffective.

The difficulty seems to have been in the inability to define particular characteristics of lighting in terms which were at the same time reasonably definite and fundamentally sound. Some of the earlier regulations were made too drastic, by specifying particular equipments or establishing limits which incurred considerable injustice, without insuring the accomplishment of the desired object. Other regulations simply required "adequate" light, which in the absence of an established standard of adequacy, left too much to personal judgment.

There was no general understanding of the fundamental principles of lighting even among engineers, until the Illuminating Engineering Society provided a medium for discussing and recording lighting information. And even yet the elements of light quantity and quality are not widely understood by the public or its legislative representatives.

Considering these conditions, the effectiveness and fairness of recently adopted regulations is truly remarkable. While these regulations are far from complete, it seems to be rather generally conceded that they have materially improved conditions, and this without serious injustice to anyone. Practically all of the recent enactments have been based upon the specifications drawn by the Illuminating Engineering Society.

In their endeavor to be fair, committees of this Society have resisted the pressure to grind out definite specifications quickly. They have chosen rather to allow liberal limits, until knowledge or experience warranted a more rigid or definite definition.

On the other hand, by introducing the foot candle, and other reproducible measures, this Society has established the foundation of determinate limits on which the more exact regulations can be based. Having definite measures which eliminate the really bad cases, it becomes practicable to change the limits by predetermined amounts until the desirable means is found.

Need of Regulations

That there is a real demand for lighting legislation seems obvious. The problem facing the lighting industry today is not whether or not we shall have lighting legislation, but rather what can be done to so guide such legislation along wise lines.

Any unnecessary regulations are, of course, to be discouraged. On the other hand, to combat all legislation is likely to result in unwise enactment which may not only prove more or less ineffective, but at the same time impose unnecessary hardship on the part of interested groups.

So long as any number of employers, through ignorance or false economy, provide inadequate or glaring illumination, so that employees are exposed to accident hazards or eyestrain, a demand for industrial lighting codes may be expected. So long as a few motorists subject other users of the highways to dangerous conditions, through improper lighting, a demand for motor vehicle lighting regulations will be felt.

That systems of lighting regulations are likely to be of importance in the future seems apparent from the following tendencies:

(a) Grouping of larger numbers of people together, thus making all safety measures more necessary, if only to avoid panic.

(b) Enlargement of buildings and other constructions, which restricts or even excludes daylight, thus necessitating provisions for ample light, either natural or artificial.

(c) Increasing night activities.

(d) Increasing volume of high-speed night travel.

Danger of Unwise Regulations

Owing to a lack of a general understanding of the fundamental features of light, and the universal confidence that "seeing is believing," the conclusions of laymen regarding light are often erroneous. It is probably because of this that optical illusions are the most deceiving. All of which points to the necessity of skilled advice and caution in the enactment of lighting legislation.

On the other hand, people have learned to distrust legislation which is prescribed by representatives of an affected group, because of the liability to prejudice in favor of the related business interest. Fortunately, in the recent proposals for lighting regulations, it has been possible to diversify the interests in such a way as to counteract each other. The illuminating engineering committees

responsible for specifications have been composed of light users as well as the various producing groups; the employee as well as the employer; the pedestrian as well as the motorist.

As examples of the sort of legislation which results when the expert is not consulted, might be mentioned the locomotive headlight laws passed in a number of states ten or fifteen years ago. These regulations merely specified the amount of light to be used, without any mention of the other characteristics of equipment. Incidentally, the amount specified was several times as much as is employed in the better practice of today, and therefore required an unnecessarily large expenditure on the part of the railroads. In fact, the laws as written did not definitely specify any useful effect. Fortunately, the railroads in certain western states did interpret them so as to be useful on single track lines, not equipped with block signals. Such a headlight was condemned by all leading experts as liable to introduce serious hazard when used on double- or four-track roads, and under certain conditions likely to produce incorrect signal readings. A serious situation was developing between the railroads and the state authorities when with its war emergency powers the Interstate Commerce Commission secured jurisdiction and succeeded in securing the withdrawal of the practice urged by the states. While its specification was not accurately descriptive, the adoption and acceptance of the incandescent headlight in a standardized form solved the problem for the present.

We are not free today from the danger of unwise regulations. In the writer's opinion the best way to avoid them when threatened is to forestall them with regulations which are fair and definite. In case of doubt, such regulations should be too liberal rather than too restrictive. Is it not best to provide for the really bad conditions, avoiding unfair rigidity, even if some doubtful conditions are not wiped out? Such regulations can be strengthened when experience shows the desirability.

Some people seem to feel a desire to provide lighting legislation for all sorts of theoretical conditions. Since all legal regulations are expensive to enforce, involve inconvenience and cost to those subject to them, and at best are likely to be more or less unfair through the inability to anticipate and describe all combinations of circumstances, it is important for the welfare of the public that enactment should be made only when a practical necessity dictates, and then should go only as far as the necessity requires.

The Recent Movement

About 1913 the Illuminating Engineering Society was invited to assist in formulating the lighting features of the Wagner Labor Laws in New York State. In this connection a group of lighting experts was brought together in a committee on lighting legislation. After two years of study and investigation a first set of specifications was produced, which with subsequent modification has formed the basis of the industrial lighting codes in the leading manufacturing states.

These codes developed some new principles of lighting legislation which rendered the work practically effective.

First, it was recognized that the art of lighting was developing so fast that no definite set of rules could be expected to hold without changes for a long period of years. Therefore, it was found best to enact into law only a general statement of what it was desired to accomplish, delegating to a commission the power to adopt detailed specification of limits and methods. This avoids the cumbersomeness and delays of legislative action, and facilitates the adoption of regulations based on practical and scientific considerations with a minimum of political dictation.

Developmental changes are more readily made, and yet excessive changes are prevented by individual responsibility and local hearings.

Another new principle was the incorporation of photometric units and more or less technical terminology, when necessary. Thus the rules were made more exact and definite, leaving less to personal judgment than before. Of course, such values and terms were not widely understood by those who were supposed to interpret the regulations but it is surprising how soon the education regarding at least the practical application of "foot candle" and other designations spread. Even at this early date the codes can be more definitely interpreted than would have otherwise been possible.

The development of an inexpensive, simple, compact, light weight, portable photometer, the foot candle meter, remarkably accelerated this movement. Today any manufacturer has little or no difficulty in finding out whether or not he is complying with the industrial lighting code or what changes are necessary to insure compliance.

When the industrial code had become fairly well standardized, there came an insistent demand for a school lighting code. This

evidently arose from the growing use of the school plant in the evening and an appreciation of the need of better equipment of all sorts for school purposes.

The experience in connection with the industrial lighting code provided an excellent basis for formulating the school lighting code, the two classes of problems having much in common. The

Fig. 1
Some of the lighting codes in effect at the present time

school lighting code of the Illuminating Engineering Society, a revision of which is now nearing completion, follows similar lines to those of the Industrial Lighting Code.

The large numbers of high speed automobiles operating after dark, brought another demand for lighting regulation. It was found difficult to light the road surface sufficiently far in advance of a car, without creating glare in the eyes of travelers approaching in the opposite direction. Thus the first effort was to eliminate glare. Later it developed that many accidents resulted from insufficient light. So codes have grown to meet these conditions by requiring more light on the roadway. Here again, educational efforts were necessary to teach an appreciation of the terms of

measurement. But still it appears easier to teach people to measure candle-power, than otherwise to tell them what constitutes a limit of adequate illumination or of dazzling light.

Another regulation activity in the motor vehicle field is that of the illumination on rear number plates, to permit reasonable identification after dark. The laws of many state statute books have been notoriously violated. It remained for Massachusetts to bring the question to an issue, and a relatively simple specification was produced to meet the demand.

State and Other Codes

Most of the codes and regulations adopted by the various states have been authorized by commissions having jurisdiction over the activities in question. Usually the state law simply specifies that safe conditions must be maintained, and authorizes the commission to promulgate and enforce detailed rules to insure that end. The complaint is not infrequently made that codes do not require good practice in lighting—in other words that they are too lenient.

Such criticism emanates from a lack of understanding of the purpose of the codes and the powers of commissions. State Commissioners usually have not the power to require the best or most efficient lighting, or even good lighting practice from the standpoint of economic operation of a factory. They can only rule out dangerous lighting conditions, and the burden often falls on the commission to prove in court that any condemned lighting really is hazardous.

No state has assumed the power, in peace time, to demand of a manufacturer that he shall run his factory in such a way as to insure maximum over all economy. So all the code can say is that the worker shall not be subjected to dangerous lighting conditions, or in the case of motor vehicle regulations that other users of the highway shall not be subjected to dangerous conditions by improper lighting.

A number of codes have pointed out in a recommendatory way, the advantages of providing better lighting than can be required on the safety basis.

Each state has, of course, its own sovereign power and can adopt such code as it may think best. We of the industry can only suggest, and show reasons for or against proposed action. There is some basis for slight variation among state codes because of dif-

ference in local conditions, and advance is made by trying out innovations. However, it would be very unfortunate if each of the 48 states should adopt its own code, varying from all others.

There is, of course, a tendency to try and better what already exists—sometimes it appears to be done with a view to showing off. On the whole there is a remarkable unity in the action so far taken, which speaks well for the basic pattern furnished by the technical experts.

The conference of Motor Vehicle Administrators has shown the enormous power which comes from united action. This has not only the greater convenience to those subject to the regulation, but also greater enforcing power on the part of the state officials.

In order to facilitate standardization of regulations throughout the country some of these regulations have been submitted to the American Engineering Standards Committee, representing the technical societies of the country, and accepted as American Engineering Standards.

Industrial Lighting Codes

The Illuminating Engineering Society's Code of Lighting Factories, Mills and Other Work Places was first issued in the summer of 1915, a second issue followed in 1918, and a third in 1920. It was adopted as an American Engineering Standard in 1921.

Pennsylvania and New Jersey were the first states to adopt the code, and they were followed by New York and Wisconsin, later California and Oregon accepted the code, the latter writing many of the details into the law itself.

Ohio adopted the code, as a guide to inspectors in 1920, and now Massachusetts will have it in force January 1, 1924. Pennsylvania is at the present time considering minor changes. Several of these states have varied the form to correspond to their local practices, and in some instances slight changes have been made in the provisions. The codes of all these states, however, are essentially the same.

In the latest codes no distinction has been made between daylight and artificial light, on the assumption that daylight will be employed when available, and when this fails to be adequate, artificial lighting will be supplied. Especially for sanitary reasons, it is desirable to have daylight enter work rooms, but there are many work rooms from which daylight is entirely excluded as in

mines and in basements of larger buildings. It has therefore seemed neither necessary nor practicable to provide that daylight shall be supplied.

The general requirement of the American Engineering Standard Code is that traversed spaces in time of use, and work in process shall be supplied with light, as specified in the rules.

These rules provide for (1) certain intensity according to the use, (2) avoidance of glare, suitable diffusion and distribution of light and (3) exit and emergency lighting.

Table 1

Intensities specified by the various industrial lighting codes

	Roads and Yards		Storage		Stairways Aisles		Rough (1) Mfg.		Rough (2) Mfg.		Medium (3) Mfg.		Fine (4) Mfg.		Very Fine (5) Mfg.		Office Work		Toilets & washrms.	
	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.	Min.	Rec.
New Jersey	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	1.25	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	....	....
Penn.	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	1.25	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	....	....
New York	.02	....	0.25	....	0.25	....	0.50	....	1.00	....	2.00	....	3.00	.....	5.00	.....	....	....	0.5	....
California	.02	0.05 0.25	0.25	0.50 1.00	0.25	1.00 2.00	0.50	1.00 3.00	1.00	2.00 4.00	2.00	3.00 6.00	3.00	4.00 8.00	5.00	7.00 15.00	....	....	0.5	....
Oregon	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	2.00	3.00 6.00	....	....	3.00	4.00 8.00	5.00	10.00 15.00	3.00	4.00 8.00	1.00	1.50 3.00
Wisconsin	.02	0.05 0.25	0.25	0.50 1.00	0.25	0.75 2.00	....	....	1.25	2.00 4.00	2.00	3.00 6.00	3.00	8.00 4.00	5.00	10.00 15.00	3.00	4.00 8.00	0.5	1.5 3.0
Ohio	.02	0.25	0.25	0.50 2.00	0.25	0.50 2.00	0.50	1.00 3.00	1.00	2.00 6.00	2.00	3.00 9.00	3.00	4.00 12.00	5.00	8.00 10.00	....	....	0.25	0.50 2.00
I. E. S.	.02	0.05 0.25	0.25	1.0 2.0	0.25	....	0.50	2.0 5.0	1.00	....	2.00	....	3.00	5.0 10.0	5.0	10.0 20.0	....	5.0 10.0	....	2.0 5.0

The intensity rule requires that working surfaces shall have from 0.5 to 5 foot candles, according to the nature of the process as described.

Five tenths of a foot candle is required for hallways, stairways, exits, while 0.25 foot candles is accepted for ordinary aisles and passages. For roadways, and yard thoroughfares, 0.02 foot candles or about the equivalent of bright moonlight is prescribed.

The intensities of one foot candle and less may be considered as intended principally to facilitate the prevention of mechanical accident, while the higher levels have the added purpose of preventing eyestrain. There are unquestionably many classes of work for which five foot candles is not adequate for eye comfort. Such processes, however, require skilled operatives, who are generally able to protect themselves without legal support. Moreover, the need of good lighting is so obviously necessary from economic considerations that no regulation seems necessary.

The various grades of work are rather generally described, with some examples to indicate the intent. Thus two foot candles is specified for "where moderate discrimination of detail is essential—work such as machinery, assembly work, bench work, fine core making in foundries, cigarette rolling."

There has been some demand for a detailed list of processes corresponding to each grade. Such a list, if practicable, would undoubtedly facilitate inspection. Several obstacles have arisen

Table 2

Specific classification of tungsten filament lamps equipped with various accessories from the standpoint of glare

	Watts.					
	10 to 25	40 to 60	75 to 100	150 to 200	300	500 to 1,000
	Grade.	*Grade.*	*Grade.*	*Grade.*	*Grade.*	*Grade.*
Bare lamps	VI	VII	VIII	IX	IX	X
Frosted lamps or frosted globes	II	III	VI	VII	VIII	.....
8-inch opal globes [1]	I	I-II	II-IV	IV-VI	.....	.....
12-inch opal globes [1]	.....	.....	II-III	II-V	IV-VI	VII-VIII
16-inch opal globes [1]	.....	.....	.....	II-V	IV-VI	V-VII
Flat reflectors—filament visible	VI	VII	VIII	IX	IX	X
Dome reflectors—steel or dense glass:						
Filament visible from working position.	VI	VII	VIII	IX	IX	X
Filament not visible from working position	I	I	III	III	IV	VI
Bowl reflectors—steel or dense glass:						
Filament visible from working position.	VI	VII	VIII	IX	IX	X
Filament not visible from working position	II	II	III	IV	VI	VII
Dome reflectors—bowl-enameled lamps	.....	.....	IV	V	VI	VI
Semi-inclosing units [1]	.....	.....	III-IV	IV-VI	IV-VII	VI-VIII
Totally indirect lighting [1]	.....	.....	I-II	I-II	II	III
Semi-indirect bowl [1]	.....	.....	I-III	II-III	II-IV	III-VI

[1] Where a range is given, the best grade, that is the lowest, applies to globes that are evenly luminous, and the poorest to globes which have a decidedly bright spot in the center.

to making such a list mandatory, for example, the same process is carried on with varying degrees of fineness in different factories, and for this reason as well as the variation in automatic machinery, gauges, etc., would not always fall in the same class. An extended list, moreover, tends to imply a greater degree of accuracy in classification than some of the experts have thought warranted. Such a list has been incorporated in the non-mandatory section of the American Engineering Standard Code and some of the states are trying such a list out on the mandatory basis. Their experience will probably guide future practice in that respect.

Table 1 compares the intensities specified in the various codes.

The second rule requires that the "lighting whether natural or artificial shall be such as to avoid glare, objectionable shadows, and extreme contrast, and to provide a good distribution of light."

It is further provided that "Lamps shall be so installed in regard to height, location, spacing and reflectors, shades or other suitable accessories, as to accomplish these objects:— Bare light sources, such as exposed lamp filaments or gas mantles, located within the ordinary field of the worker's vision, are presumptive evidence of glare."

Reference is given to a tabular scheme, by which illuminants and accessories are graded with respect to their glare producing power.

Permissible equipments, and their locations with regard to the various grades of work are indicated. While apparently more or less complicated, this scheme is not difficult to comprehend

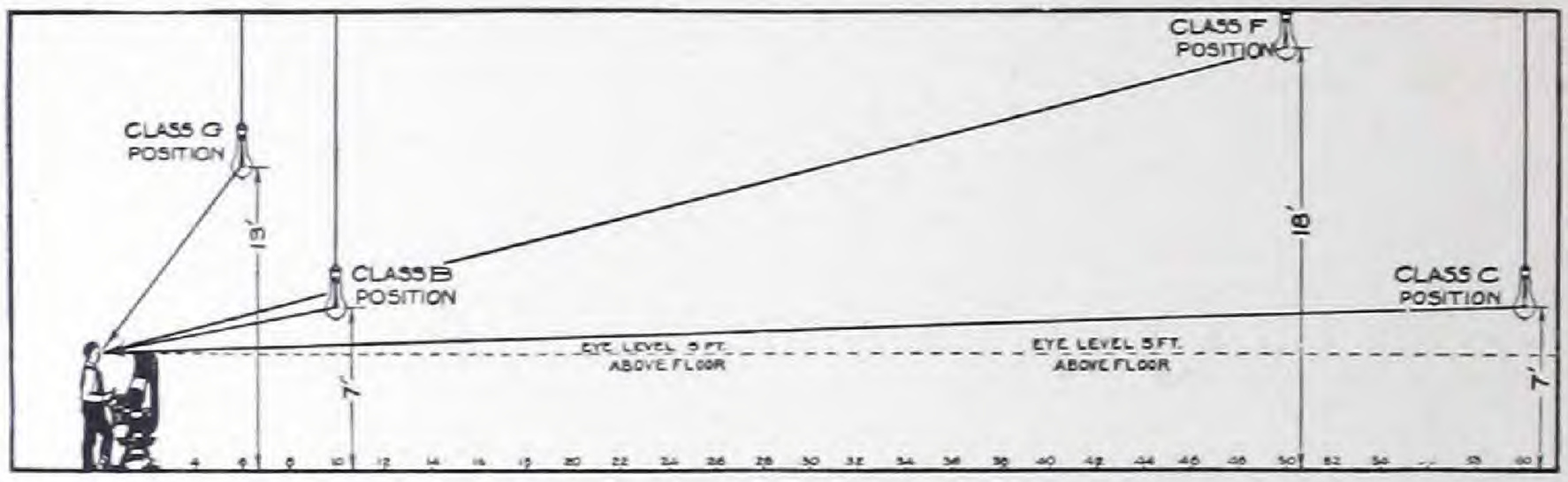


Fig. 2

Diagram illustrating typical positions given in the chart of field of view. (See Table 3)

and apply. It is by far the best means so far discovered for facilitating the interpretation of the rule. There is presented with it a discussion of the various factors affecting glare and an explanation of the derivation and use of the scheme.

The method of rating lighting units as to their glare producing properties is so novel and logical that it seems desirable to outline briefly here the scheme employed.

Five principal causes of glare are taken into consideration, viz.: Brightness of source, total volume of light, location in field of view, contrast with background and time of exposure. The first two factors concern the light source itself, the third factor concerns its location, while the fourth and fifth depend upon the conditions of its use.

All commercial light sources, gas, arc, incandescent and mercury vapor lamps as well as natural light sources, are graded into ten classes which take into account both brightness and candle-

power. Table 2 indicates the classification of tungsten filament lamps with various accessories. Grade I represent the minimum glare while Grade X the maximum.

To take into consideration the third factor, namely, location of the light source in the field of view, the diagram, Fig. 2, and

Table 3
Chart of the field of view

CLASSIFICATION OF POSITION OF LIGHT SOURCE WHICH TAKES INTO ACCOUNT THE DISTANCE FROM THE EYE AND THE ANGLE OF THE LINE OF VISION.[1]

Height above floor, in feet.	Horizontal distance of light source from observer, in feet.															
	1	2	3	4	6	8	10	12	16	20	25	30	35	40	50	60 and up.
6.5 or less	[2]A	[3]A	A	A	A	A	A	A	A	A	A	A	B	B	B	B
6.5 to 7	G	E	D	C	C	B	B	B	B	B	B	B	B	B	B	C
7 to 8	G	G	F	E	D	D	C	C	C	C	C	C	C	C	C	C
8 to 9	G	G	G	F	F	E	D	D	C	C	C	C	C	C	C	D
9 to 10	G	G	G	G	F	F	E	E	E	D	D	D	D	D	D	D
10 to 11	G	G	G	G	G	F	F	F	E	E	D	D	D	D	D	D
11 to 12	G	G	G	G	G	F	F	F	F	F	E	E	D	D	D	D
12 to 13	G	G	G	G	G	G	F	F	F	F	E	E	E	E	E	E
13 to 14	G	G	G	G	G	G	G	G	F	F	F	F	E	E	E	E
14 to 15	G	G	G	G	G	G	G	G	G	F	F	F	F	E	E	E
15 to 16	G	G	G	G	G	G	G	G	G	G	F	F	F	E	E	E
16 to 17	G	G	G	G	G	G	G	G	G	G	F	F	F	F	E	E
17 to 18	G	G	G	G	G	G	G	G	G	G	G	G	F	F	E	F
18 to 19	G	G	G	G	G	G	G	G	G	G	G	G	G	G	F	F
19 to 20 and up	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G

Table 3, are presented. Their use is quite obvious and needs no explanation.

It is apparent that some classes of work are much more exacting than others as to the effect of glare. A given light source in a certain position may be satisfactory for one use and not for some

Table 4
Limiting grades of light source permissible for various conditions

Classification of position.	Space or work to be lighted.			
	Roadways and yard thoroughfares.	Storage spaces, aisles, stairways, handling coarse material.	Ordinary manufacturing operations.[1]	Offices and drafting work and certain manufacturing operations.[2]
	Limiting grade.	*Limiting grade.*	*Limiting grade.*	*Limiting grade.*
A	VI	V	III	II
B	VII	VI	V	IV
C	VIII	VII	VI	V
D	IX	VIII	VII	VI
E	IX	IX	VIII	VII
F	X	X	IX	VIII
G	X	X	X	X

[1] For the present the limits set in this table can not be rigidly applied to portable lamps used for temporary work, such as setting up machines, repairing automobiles, etc.
[2] Those operations in which workers are seated facing in one direction for long periods of time.

other. Table 4 shows these limitations, taking into consideration the factors previously discussed.

The third rule covers Exit and Emergency Lighting, and reads as follows: "The lighting to be provided under Rule 1 in all stairways and exits of factories and in the passageways appurtenant thereto shall be supplied so as not to be subject to failure because of the failure of the room or work space lighting from internal causes, and preferably from an independent connection extending back to the main service entrance for the building. In case of unusual danger which may exist on account of type of building, nature of the work, crowded conditions or lack of suitable exit space, an independent service shall be ensured by connecting to a separate source of supply without or within the building."

This rule is in general self explanatory. It is obviously made flexible to conform to local facilities, and requires only what is necessary to insure safety.

That continuity of service be maintained is a lighting consideration. How this shall be accomplished is an electrical problem, and in some states is already covered in wiring regulations. The lighting code naturally avoids going far into detail regarding it. The industrial lighting codes have now been in force from five to seven years, and have in general become well stabilized. However, manufacturing methods are developing, the lighting art is advancing, and experience is being accumulated as to the enforcement of the code. With all these changes it should be expected that changes in the codes would become desirable.

The industrial lighting codes have unquestionably accomplished much good. It has been the experience of the State Commissions that manufacturers generally desire to comply with the regulations, and that failure has been more often due to lack of understanding than to intentional neglect. Large manufacturers usually employ competent engineers, and have means available for the study of their lighting problems. Such manufacturers, in order to secure manufacturing economies, ordinarily provide better lighting than is legally required. The worst offenders are the smaller manufacturers, especially what is known as the "sweatshop" class.

When a single individual has a wide variety of functions, he has little opportunity of spending much time informing himself on any one—and lighting seems to be commonly overlooked. It is this group for which the codes are really needed, and many of them have expressed appreciation for economic gains called to their

attention, in the endeavors to secure their compliance with the code. This leads to the conclusion that ordinarily the enforcement of the code can best be accomplished by educational rather than by arbitrary methods. Excellent results have been obtained in several states where the educational method predominated. There are, of course, some instances of abuse. A few inspectors apparently think they can make a better showing by criticizing a few large manufacturers for technicalities, than by correcting serious conditions existing in a large number of small shops.

It is to be hoped that the state authorities will guard against such practices, and direct their main efforts first to the elimination of really dangerous conditions.

School Lighting Codes

As already pointed out the School Lighting Code is a later development than the industrial. In general it has followed similar lines and as far as practicable the provisions have been patterned after those of the industrial code.

The school is more essentially a daylight plant, so that regulation of daylight necessarily takes a more predominant place. The control of daylight is more a matter of building construction and it is no simple problem to make specifications applicable to the large school in a crowded section of a city, and at the same time to the country school house, and all the intervening conditions.

In the city it is often impracticable to prevent the obscuration of daylight by tall buildings, which may be erected after the school is completed.

The Illuminating Engineering Society's code was issued in 1918. In 1921 Wisconsin adopted a code based upon it.

In New York State, compliance with the I.E.S. code is required of all schools receiving state aid. With the later experience gained the I.E.S. code is now being revised, for submission to a sectional committee of the American Engineering Standards Committee under the joint sponsorship of the American Institute of Architects and the Illuminating Engineering Society.

The school lighting code requires that when in use during daylight hours, the rooms in which pupils study or do other work shall be provided with natural light and when daylight fails, they shall be provided with artificial light, and in either case the light shall conform to the detailed rules.

All other rooms and spaces may have either natural or artificial light, provided the rules set forth below are observed.

Rule 1 specifies the level of illumination required, and recommends that certain higher values be provided as in Table 5.

Rule 2 calls for the avoidance of harmful glare, objectionable shadows and extreme contrasts, it being pointed out that exposed lamp filaments and mantles, as well as sky areas in the field of view are presumptive evidence of glare.

It is required the seating be such as not to compel pupils to face windows.

Table 5

Intensities set forth in the Illuminating Engineering Society Code of Lighting School Buildings

On the Space	Foot Candles	
	Minimum Required	Recommended
Walks, drives and other frequented outdoor areas, if used at night	0.1	0.5
Playgrounds, outdoor, if used at night, baseball, basket ball, etc.	0.5	2-5
Storage spaces, passages not used by pupils	0.25	2
Stairways, landings, corridors, aisles, main exits, elevator cars, washrooms, toilets	1	3
Boiler rooms, power plants and similar auxiliary spaces	1	3
Locker spaces	1	3
Recreation rooms, gymnasiums, swimming pools	3	7
On the Work		
Auditoriums, assembly rooms (Important reading surfaces)	3	7
Classrooms, study rooms, desk tops, blackboards, charts, etc., (auditoriums or other spaces when used for class or study purposes shall meet this requirement)	5	10
Library (reading tables, catalogues, book shelves)	5	10
Laboratories—tables, apparatus	5	10
Manual training rooms, workshops, etc.	5	10
Drafting rooms, sewing	8	15

Reference is made to a classification of the causes of glare similar to that applied to the code of lighting for mills, factories and other work places.

Rule 3 treats of the distribution of light which must be reasonably uniform. For artificial lighting it is required that the variation on desk top and other work places shall not exceed four to one.

Rule 4 specifies the color and finish of the interior, requiring walls with a reflection factor of 35 to 50 per cent and ceilings of such a character as to reflect at least 65 per cent of the light.

Switching and controlling apparatus, exit and emergency lighting are discussed in the next two rules, while Rule 7 makes necessary a systematic inspection and maintenance service.

The concluding paragraph states that blackboards shall be illuminated and located with respect to light sources so as to avoid glare, that they shall have dull rather than glossy surfaces and not be placed between windows which are only a few feet apart.

Since the welfare of the coming generation is involved, it is to be hoped that a good code will be actively applied. Pupils pursue a task only through the learning period, while a worker often continues for many years after skill is acquired. It follows that the pupil requires better light for a corresponding operation. Unfortunately the practice, in the past at least, as far as artificial lighting is concerned, has been to provide the pupil with much poorer light. There has been a very considerable improvement in many places during the last two years, and the indications are that the importance of school lighting is becoming more and more generally appreciated by school boards. Therefore we can anticipate accelerated progress in the future.

Motor Vehicle Headlight Regulations

The mounting number of night accidents, following the increase in high speed motor travel, naturally resulted in a demand for better headlighting regulations.

This condition developed very rapidly and there was but very little experience available to guide in the formulation of regulations, so that extensive laboratory and road tests were necessary, before suitable specifications could be drawn.

The problem was simplified by the general practice which had been established, namely, of using two equal powered lights, equipped with parabolic reflectors of a few sizes, also by the extending use of concentrated filament MAZDA lamps of but a few sizes.

Difficulties were presented by the fact that the maximum light was necessitated in directions which approached rather close to those where there was the greatest liability of glare production, and further due to undulations and curvature of road surfaces, as well as the motion of the vehicle, it is not practicable to prevent flashes of light in the glare angle.

The regulations require suitable lighting for safe operation on unlighted roads, by specifying sufficient illumination on the road

surface in advance of the vehicle, and limiting the illumination in the direction where the light is likely to fall on the eyes of the driver of a vehicle approaching on his proper side of the highway.

Due to the standardization of equipment it was found most practicable to specify these values in beam candle-power, for certain directions with reference to the vehicle axis.

Under these conditions beam candle-power becomes a measure of illuminating power and glare producing power.

In formulating the earlier specifications, it was felt that glare was the most serious menace and especial attention was given toward its elimination. It was also considered necessary to have

Table 6

Partial list of headlight devices approved by the Motor Vehicle Commissioners in a group of Eastern States for the year 1923. Properly applied these devices meet the specifications as laid down in Fig. 3

Alpheco (8⅛ in. only)
Bausch & Lomb
Benzer Type A
Brown (Reflector)
Conaphore, Type F (Clear and amber colored)
D. B. (Dodge Bros.—8⅝ in. only)
Dillon Type 1
Flintex
Ford H (8⅛ in. only)
Guide Ray Type A (Headlamp)
Hudson (8⅛ in. only)
Lee Knight
Legalite M 111
Liberty
Liberty Type D
McKee Spreadlight
Miro-Tilt (Headlamp) (Wills St. Claire)
Monogram (Durant, Grant, Maxwell, Oldsmobile, Overland, R. & V. Rickenbacker, Stearns, Stutz, Velie, W.K.)
Osgood B 23
Patterson
Parab-O-Lite Type FW
Smith

specifications which could be complied with in the existing state of the art, so the illumination features were not made very severe.

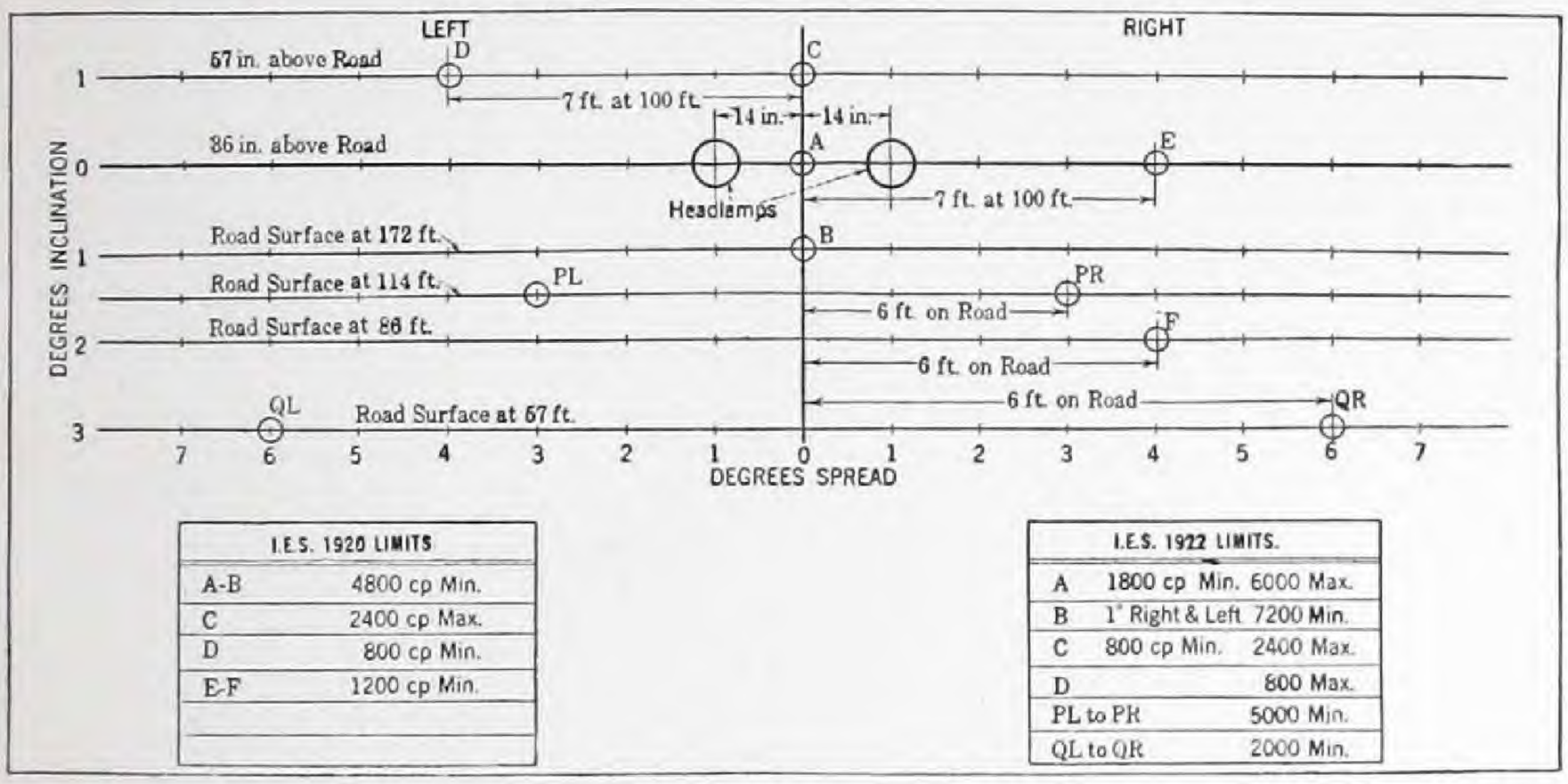
Later experience showed the necessity of providing more light on the road, and a wider spread. The developments in lenses made this practicable, so the requirements were strengthened in regard to these features, the principal glare limit being still maintained at the original value.

It was unreasonable to require drivers to comply with specifications, if the regular equipment on sale was not capable of complying, so in promulgating the regulations the first effort was to permit the sale of only such equipment as could comply.

To facilitate the selection of acceptable equipment, especially lenses, specifications for laboratory acceptance tests were prepared.

On the basis of such tests, the various states have published lists of acceptable devices, which protect the purchaser from unsatisfactory equipment (Table 6).

However, good equipment requires careful focusing and adjustment, to insure suitable illumination and freedom from serious glare. While these adjustments are not particularly difficult to make, considerable difficulty has been encountered in educating the vast numbers of users, regarding the necessity and method of adjustment. This problem still demands a considerable amount of study and experimentation. In some places official adjusting stations have been established and drivers of vehicles with lights which appear to be improperly adjusted, are required to submit to test and expert adjustment, for which a small fee is usually charged.



I.E.S. 1920 LIMITS	
A-B	4800 cp Min.
C	2400 cp Max.
D	800 cp Min.
E-F	1200 cp Min.

I.E.S. 1922 LIMITS.		
A	1800 cp Min.	6000 Max.
B	1° Right & Left	7200 Min.
C	800 cp Min.	2400 Max.
D		800 Max.
PL to PR		5000 Min.
QL to QR		2000 Min.

Fig. 3
Diagram of test positions and candle-power requirements for headlights as specified by the committees on motor vehicle lighting, Illuminating Engineering Society and Society of Automotive Engineers

Some ingenious equipment has been devised for facilitating such adjustment. In general, however, the driver is dependent upon the printed instructions which the manufacturer is required to furnish with each pair of devices.

The 1922 Specifications of the Illuminating Engineering Society have been made an American Engineering Standard under the joint sponsorship of the Illuminating Engineering Society and the Society of Automotive Engineers. Regulations based on this system, and in most cases practically identical with the Illuminating Engineering Society proposal, are in force in the states representing over half of the automobile registration of the United States, namely, Maine, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Ohio, Wisconsin, Iowa, Utah, California, and Oregon.

Fig. 3, taken from the report of the Illuminating Engineering Society's Committee (*Transactions I.E.S.*, 1922, No. 2, p. 109), indicates the candle-power requirements.

Motor Vehicle Tail Light Regulations

The laws of many of the states make the following requirements for the tail lights of motor vehicles:

(1) Shall exhibit a red light visible five hundred feet from the rear.

(2) Shall illuminate the rear number plate, so as to render it legible for a distance of sixty feet from the rear.

No difficulty has been encountered with regard to the first requirement, but the second has been notoriously violated, so that observation tests have indicated that only one out of some four hundred automobiles provide proper illumination. The situation has been growing worse as the states have enlarged their number plates, and no one has seen to it that the equipment was modified to meet the change.

It is certainly as important to be able to read a number plate at night as in the daytime, especially when it is considered that criminal activity is greater in the dark.

Massachusetts was the first state to undertake the rectification of this condition.

Preliminary specifications were issued and announcement made that beginning with 1923, no devices failing to comply with the law would be permitted to be sold in the state. This announcement, coupled with the likelihood of similar action in other states, resulted in a prompt redesign of tail lighting equipment by all the leading manufacturers, irrespective of whether or not the equipment was for use in Massachusetts.

At the request of the Massachusetts Motor Vehicle Department, joint committees of the Illuminating Engineering Society and Society of Automotive Engineers undertook the preparation of an engineering specification for rear lamps to insure compliance with the law. Tests were run which indicated the practicability of meeting the requirements with the two-candle-power electric incandescent lamps, already in use for this service.

The specifications prepared by the committees correspond to those already in use in Massachusetts, but were made more general in application by employing light values in place of certain mechan-

ical dimensions. An illumination of at least five-tenths foot candle with a ratio of variation of illumination not exceeding 30, is prescribed. (See *Transactions I.E.S.*, Feb., 1923, p. 280.)

In order to insure the correct relative position of the light source and number plate, it is required that the rear lamp and plate support be made up as one part or, if separable, so marked as to indicate that they go together.

In connection with this work the committee pointed out the fact that legibility depends upon the size and form of numerals, color contrast, and dimensions of the plate, as well as on the lighting equipment. An interstate program of plate standardization was therefore urged.

Fig. 4
New tail light device of low cost for a popular make of automobile

The regulations have been in force too short a time to accumulate much experience, but the indications are that they will prove quite satisfactory. So far as the recently manufactured tail lights are concerned the situation seems to be settled.

The main problem is to secure the installation of approved equipment on machines in service previous to 1923.

As acceptable devices can be obtained at a relatively low cost to the individual owner (see Fig. 4), this should not be serious.

No focusing adjustment is involved as is the case with the headlight.

Future Legislation

The codes and regulations already adopted will undoubtedly be changed from time to time, to meet changing conditions and take advantage of developments in the lighting art, but no radical changes seem likely at the present time.

Undoubtedly codes will be adopted to regulate the lighting in other fields, for example, lighting of auditoriums and assembly rooms, traffic signal lighting, general exit lighting, lighting of subways, tunnels, mines, etc.

On the other hand, such legislation usually proceeds where public necessity dictates. Regulations are not likely to be demanded wherever it is the general practice of lighting to provide for safety. Educational work toward the promotion, will unquestionably do much to minimize the extension of compulsory regulations.

Bibliography

Industrial Codes

"Resume of Legislative Enactment on Illumination," E. L. Elliott, *Trans. I.E.S.*, Vol. 6, p. 722.

"Code of Lighting for Factories, Mills and Other Working Places, 1915," *Trans. I.E.S.*, Vol. 10, p. 605.

"Lighting Legislation," L. D. Marks, *Trans. I.E.S.*, Vol. 11, p. 47.

"Modern Aspects of Factory Lighting and the New Code," C. E. Clewell, *Trans. I.S.E.*, Vol. 11, p. 436.

"Code of Lighting for Factories, Mills and Other Working Places, 1918," *Trans. I.E.S.*, Vol. 13, p. 256.

"Report Committee on Lighting Legislation," *Trans. I.E.S.*, Vol. 13, p. 524

"Present Status of the Industrial Lighting Codes," G. H. Stickney, *Trans. I.E.S.*, Vol. 14, p. 153.

"Industrial Lighting Code of Wisconsin," J. A. Hoeveler, *Trans. I.E.S.*, Vol. 14, p. 436.

"Industrial Lighting Code of New York," *Trans. I.E.S.*, Vol. 14, p. 454.

"Industrial Lighting Code of New Jersey," R. H. Leveridge, *Trans. I.E.S.*, Vol. 14, p. 461.

"Industrial Lighting Code of Pennsylvania," J. S. Spier, *Trans. I.E.S.*, Vol. 14, p. 468.

"Federal Rules for Industrial Lighting and Eye Protection," M. G. Lloyd, *Trans. I.E.S.*, Vol. 14, p. 473.

"Insurance Co. Inspector and Lighting Codes," R. E. Simpson, *Trans. I.E.S.*, Vol. 14, p. 478.

"Code of Lighting for Factories, Mills and Other Working Places," *Trans. I.E.S.*, Vol. 16, p. 363.

"Practical Aspects of the I.E.S. New Code of Lighting," C. E. Clewell, *Lighting Journal*, October, 1915.

"Establishing a Basis for Laws on Lighting," C. E. Clewell, *Electrical World*, December 25, 1915.

"Legal Requirements of Factory Lighting," C. E. Clewell, *Electrical World*, June 23, 1917.

"Changing Aspects of Factory Lighting Legislation," C. E. Clewell, *Electrical World*, March 23 and 30, 1918.

"Factory Inspectors Study Industrial Lighting," C. E. Clewell, *Electrical World*, July 6, 1918.

"Development of Factory Lighting Codes," G. H. Stickney, *Electrical World*, July 6, 1918.

"Industrial Session for Special Guidance of State Factory Inspectors held at Boston, 1918," *Electrical World*, November 9, 1918, p. 904.

"Lighting Legislation," H. E. Mahan, *General Electrical Review*, February, 1919.

"Progress in Legislation on Factory Lighting in U. S.," G. H. Stickney, *Illuminating Engineering* (British), July, 1919.

"Modern Industrial Lighting in Oregon," F. H. Murphy, *Electrical World*, October 23, 1920.
"International Industrial Lighting Codes," *Electrical Review*, March 12, 1921.

School Codes

"Eyesight and Artificial Illumination," John T. Krall, *I.E.S.*, Vol. 3, p. 219.
"Safeguarding the Eyesight of School Children," M. Luckiesh, *Trans. I.E.S.*, Vol. 10, p. 193.
"Report on Code of Lighting of School Buildings, 1918," *Trans. I.E.S.*, Vol. 13, p. 185.

Motor Vehicle Headlamps

"Automobile Headlights, Report of Committee on Glare," *Trans. I.E.S.*, Vol. 11, p. 29.
"A Survey of the Automobile Head Lamp Situation," W. F. Little, *Trans. I.E.S.*, Vol. 12, p. 123.
"Report of the 1916–17 Committee on Automobile Head Lamp," *Trans. I.E.S.*, Vol. 13, p. 259.
"Report of Committee on Automobile Headlighting Specifications," 1918-19, *Trans. I.E.S.*, Vol. 14, p. 500.
"New York State Automobile Head Lamp Law," F. M. Hugo, *Trans. I.E.S.*, Vol. 14, p. 61.
"Proposed Regulation for Incorporation in a Model Law with Regard to Head Lamps on Motor Vehicles," *Trans. I.E.S.*, Vol. 14, p. 101.
"Present Status of Auto Head Lamp Regulation," *Trans. I.E.S.*, Vol. 16, p. 469.
"Motor Vehicle Head Lamp Law of Massachusetts," A. W. Devine, *Trans. I.E.S.*, Vol. 16, p. 507.
"Rules Governing the Approval of Headlighting Devices for Motor Vehicles," *Trans. I.E.S.*, Vol. 17, p. 105.

Motor Vehicle Rear Lamps

"Report of Committee on Motor Vehicle Lighting," *Trans. I.E.S.*, Vol. 18, p. 30.
"Tail Light and License Plate," G. H. Stickney, *Trans. I.E.S.*, Vol. 18, p. 111.
"Specifications Governing the Acceptability of Electric Tail Lamps for Motor Vehicles," *Trans. I.E.S.*, Vol. 18, p. 208.
"Lighting Automobile License Plates," J. A. Summers and W. G. Morrison, *Automotive Industries*, November 14, 1922.

EDISON LAMP WORKS
OF
GENERAL ELECTRIC COMPANY

GENERAL SALES OFFICE, *HARRISON, N. J.

SALES OFFICE (Address nearest office):

AKRON, OHIO, Second National Building.
*ATLANTA, GA., Citizens and Southern Bank Building.
BALTIMORE, MD., Lexington Street Building.
BIRMINGHAM, ALA., Brown-Marx Building.
BLUEFIELD, W. VA., Law and Commerce Building.
*BOSTON, MASS., 84 State Street.
BUFFALO, N. Y., Electric Building.
*BUTTE, MONT., Electric Building.
CHARLESTON, W. VA., Charleston National Bank Building.
CHARLOTTE, N. C., Commercial National Bank Building.
CHATTANOOGA, TENN., James Building.
*CHICAGO, ILL., Monadnock Building.
*CINCINNATI, OHIO, Provident Bank Building.
CLEVELAND, OHIO, Illuminating Building.
COLUMBUS, OHIO, The Hartman Building.
DAYTON, OHIO, Dayton Savings and Trust Building.
*DENVER, COLO., U. S. National Bank Building.
DES MOINES, IOWA, Hubbel Building.
DETROIT, MICH., Dime Savings Bank Building.
DULUTH, MINN., Fidelity Building.
ELMIRA, N. Y., Hulett Building.
ERIE, PA., Commerce Building.
FT. WAYNE, IND., 1600 Broadway.
GRAND RAPIDS, MICH., Commercial Savings Bank Building.
HARTFORD, CONN., Hartford Ætna National Bank Building.
INDIANAPOLIS, IND., Traction Terminal Building.
JACKSON, MICH., Central State Bank Building.
JACKSONVILLE, FLA., Graham Building.
*KANSAS CITY, MO., Dwight Building.
KNOXVILLE, TENN., Burwell Building.
LITTLE ROCK, ARK., Southern Trust Building.
*LOS ANGELES, CAL., Corporation Building, 724 S. Spring Street.
LOUISVILLE, KY., Starks Building.
MEMPHIS, TENN., Exchange Building.
MILWAUKEE, WIS., Public Service Building.
*MINNEAPOLIS, MINN., 410 Third Avenue, North.
NASHVILLE, TENN., Stahlman Building.
NEWARK, N. J., 671 Broad Street.
NEW HAVEN, CONN., Second National Bank Building.
*NEW ORLEANS, LA., Maison-Blanche Building.
*NEW YORK, N. Y., Equitable Building, 120 Broadway.
NIAGARA FALLS, N. Y., Gluck Building.
OMAHA, NEB., Electric Building.
*PHILADELPHIA, PA., Witherspoon Building.
*PITTSBURGH, PA., Oliver Building.
*PORTLAND, ORE., Electric Building.
PROVIDENCE, R. I., Turks Head Building.
RICHMOND, VA., Virginia Railway and Power Building.
ROCHESTER, N. Y., Granite Building.
*ST. LOUIS, MO., Pierce Building.
*SALT LAKE CITY, UTAH, Newhouse Building.
*SAN FRANCISCO, CAL., Rialto Building.
SCHENECTADY, N. Y., G. E. Works.
*SEATTLE, WASH., Colman Building.
SPOKANE, WASH., Paulsen Building.
SPRINGFIELD, MASS., Third National Bank Building.
SYRACUSE, N. Y., Onondaga County Savings Bank Building.
TACOMA, WASH., 1009–1010 W. R. Rust Building.
TERRE HAUTE, IND., Terre Haute Trust Building.
TOLEDO, OHIO, Spitzer Building.
TRENTON, N. J., Broad Street National Bank Building.
WASHINGTON, D. C., Commercial National Bank Building.
WORCESTER, MASS., State Mutual Building.
YOUNGSTOWN, OHIO, Stambaugh Building.

FOR TEXAS, OKLAHOMA and ARIZONA business, refer to SOUTHWEST GENERAL ELECTRIC COMPANY (formerly Hobson Electric Company).

*DALLAS, TEXAS, Interurban Building.
*EL PASO, TEXAS, 206 San Francisco Street.
*HOUSTON, TEXAS, Third and Washington Streets.
*OKLAHOMA CITY, OKLA., 1 West Grand Ave.
PHOENIX, ARIZ., 211 Monihon Building.
*SAN ANTONIO, TEXAS, City National Bank Building.
TULSA, OKLA., Cosden Building.

*** Stock of lamps at these points**

EDISON LAMP FACTORIES

AMPERE, N. J.
BELLEVILLE, N. J.
EAST BOSTON, MASS.
FT. WAYNE, IND.
HARRISON, N. J.
NEWARK, N. J.
OAKLAND, CAL.
ST. LOUIS, MO.
SCRANTON, PA.

3-1-23